Isotopic Evaluations to Add Value to Nutritional Interventions
Draft Thematic Plan
25 May 1998

1. Development Need Addressed:

The application addresses the need to ensure that nutrition interventions are undertaken in the optimal way, using reliable biological indicators. Such interventions would normally comprise either food supplementation, fortification or dietary alterations, but could also be educational campaigns. It should be noted that, in many middle-income countries, the emphasis in national campaigns is currently moving from malnutrition to healthy ageing. The end-users of the monitoring and evaluation of intervention programmes would usually be Public Health Agencies undertaking such interventions. Global priorities addressed include poverty alleviation (World Summit for Social Development, 1995), reproductive health (International Conference on Population and Development, 1994), children's issues (World Summit for Children, 1990), the fight against malnutrition (International Conference on Nutrition, 1992) and elimination of hunger (World Food Summit, 1996).

2. Solution

Nuclear techniques can never solve a nutrition problem. However, the importance of these techniques is that they can supply decision-makers with information which will help them optimise interventions in terms of outcome and costs. Isotope investigations could, for instance, help determine the need for an intervention or the efficiency of an on-going programme, or point to the optimal composition and dosage of a food supplement.

It should be noted that other nuclear techniques (mutation breeding) can also be used to address micronutrient issues by enhancing the concentration and bioavailability (uptake) of nutrients in crop varieties and minimising toxic constituents.

3. Description of sub-sector where the IAEA operates

Good nutrition is essential if people are to achieve their full biological and social potential. Yet over 800 million people around the world are chronically malnourished. Among vulnerable groups, malnutrition most seriously affects the survival and growth of children, the health of pregnant and lactating women, overall resistance to diseases and performance in school and at work. In terms of micronutrients, iron deficiency is the world's most common nutrient deficiency. Two billion people suffer from iron deficiency anemia of which about 50% is dietary in origin. Women of childbearing age, infants, children and teenagers are especially affected. Iron deficiency diminishes the ability to fight infections, increases risks of premature delivery, maternal and foetal illness or death, and impairs learning and growth potential in children. Due to its effects of on human productivity and links to poverty alleviation, **nutrition is a major health sector priority in developing countries**. Compared to diseases which occur relatively late in life, such as cancer and heart disease, nutrition appears more prominently in the national health plans of developing countries. Consequently, a large number of international organisations, including UNICEF, WFP, UNHCR and the World Bank support nutritional interventions. On the scientific and norm-setting side, WHO is also an important player. FAO has some involvement in nutrition as it relates to food safety.

Nutritional interventions generally aim to increase energy and protein intake, and/or to compensate for deficiencies of specific micronutrients and vitamins. This is achieved either by distributing a supplement, by fortifying other foods, such as salt or wheat, by managing a dietary alteration or by providing advice to improve knowledge in local communities. Outside emergency situations it is generally intended that such interventions should be made in a sustainable manner. The government institutions responsible for such interventions are Public Health Agencies generally attached to the Ministry of Health or the Ministry of Social Development. If it is a school food intervention, the Ministry of Education may also be involved. As for the UN organisations, these work more or less independently. UNICEF prefers to work directly through its own local offices, with the endorsement of the Government. WFP and the World Bank prefer to work through the Public Health Agencies.

4. Role of nuclear/isotope technology

Isotopes (both radioactive and non-radioactive), enable detailed evaluations of nutrient intake (e.g. through breastmilk), status of micronutrients and vitamins, body composition, energy expenditure, and bioavailability (the proportion that is absorbed and used) of nutrients in foodstuffs, supplements and fortificants.

5. Limitations

TC does not aim to finance nutritional interventions. Nor should TCF resources be used for nutritional research without established linkages to actual interventions. The assistance should be confined to cases where assistance is sought to improve an intervention, and the responsible entities are firmly committed to absorbing the recommendations resulting from a study. In order to strengthen its role in development in this area, the Agency should actively pursue partnerships with the lead UN agencies with field projects in nutrition, including WFP, UNICEF and the World Bank.

As regards evaluations of vitamin-A status, it should be noted that an Agency co-ordinated research programme (CRP) aims to develop and apply isotopic techniques for this purpose. Pursuant to recommendations from the technical division, no further TC projects on this topic should be approved, pending positive results from this CRP, which is set to end in December 1998. This applies to all evaluation techniques in nutrition which are not yet fully developed, tested and recommended for wide use.

6. Basic components of national activities

Isotopic evaluations require laboratories equipped for Isotope Ratio Mass Spectrometry (IRMS), Radioimmunoassay (RIA), gas chromatography, mass spectrometry, nuclear magnetic resonance and various nuclear methods for minerals.

The table below shows some of the type of studies that can be carried out by use of stable and radioactive isotopes, and the cost of related equipment.

Table 1: Isotope investigations

Evaluation	**Determined through the following isotope technique**	**Necessary capabilities (technology, lab.)**	**Price of equipment (in US $)**
Iron status; effectiveness of iron supplementation or fortification.	Serum-ferritin for iron status. Uptake of radioactive or stable isotopic iron into red cell haemoglobin for iron bioavailability.	Radioimmunoassay (RIA) gamma-counter Whole Body Counter Liquid Scintillation Counter Inductively Coupled Plasma Mass Spectrometry (ICP/MS)	55k 25k has to be specially made on site 25k 150k -500k
Zinc status; effectiveness of zinc supplementation or fortification	Zinc uptake; Zinc body stores (*in vivo* kinetics, stable isotopic Zn)	Whole Body Counter ICP/MS	100k-1,000k 150k - 500k
For instance, effect of food given to mothers on reproductive health; effect of education or counselling	Breastmilk intake (*in vivo* kinetics ^2H_2O)	Isotope Ratio Mass Spectrometry (IRMS) or Infrared Spectroscopy (FTIR)	150k 40k
Nutrient requirements of target groups; intra-familial behaviour (usage of food provided)	Energy expenditure (*in vivo* kinetics ^2H_2O, $H_2{}^{18}O$)	IRMS or FTIR	150k or 40k
Percentage body fat; risk to severe malnutrition or obesity	Body composition (^2H_2O)	IRMS or FTIR	150k or 40k
Vitamin A status[1]	Vitamin A body stores; Bioavailability of pro vitamins (*in vivo* kinetics, ^{2}H-retinol)	Gas Chromatography Mass Spectrometry (GC/MS)	150k
Helicobacter Pylori infection; links to diarrhoeal disease and cancer	^{13}C-urea breath test	IRMS	150k

The IAEA should make efforts to use existing facilities and capabilities in target countries, where available. This follows from the fact that the applications of the relevant technologies are, by no means, confined to nutritional work. For instance, IRMS and RIA laboratories originally developed, with or without Agency assistance, for other purposes could be used to analyse samples related to nutritional evaluation. It is thus important not to confine the search for partners to institutions involved in nutrition. At least two sites (Chile and Pakistan) are currently using equipment and expertise originally intended for non-nutritional work in nutritional programmes involving isotopes.

Where local analytical capabilities are not sufficient, attempts should be made for analyses to be conducted (in order of preference):

a) **within the region**. Capabilities may not always be available for IRMS but will usually be available for RIA.

b) **in collaboration with an institute in another developing country**. Sub-contracting arrangements could be considered in order to further TCDC and support developing country applications.

c) **in collaboration with an industrial country laboratory.** The choice of partner is to be made by the national counterpart with Agency advice, but existing twinning or other partnership arrangements should be taken into account.. Partnership arrangements are a good way to proceed if the collaboration is mutually beneficial. However, developed country laboratories are increasingly under pressure to fund their work from outside sources and often charge overheads that can sometimes bring costs close to commercial ones. For a genuine collaboration the expectation is that charges ought to be no more that 50% of the commercial cost.

d) **through sub-contracting arrangements with commercial analytical laboratories**. This may have some advantages in terms of getting the work completed to an agreed timetable.

7. Criteria for selecting participants and identifying candidates:

- Nutrition intervention in need of evaluation (**"go or no-go" criteria**).
- Direct link between TC counterpart and public health agency responsible for the nutritional intervention (**"go or no-go" criteria**).
- Multidisciplinary approach to nutritional intervention in the country (partnership with social authorities is important for a successful evaluation of a programme).
- Explicit commitment of responsible public health agency to absorb the recommendations of the investigation and use it as a basis to amend the intervention if so required (a clear idea of how the information is to be used should be spelled out in the document).
- Existing networks, both involving TC's counterpart institutes and public health agencies involved in nutritional interventions, are to be seen as an added advantage. A model for such collaborative networks is the one in Latin America, involving a centre of excellence in Chile.
- High probability of public acceptance of nutritional intervention on the one hand and isotopic investigations on the other.
- If the intervention is carried out through a multilateral or bilateral programme, it should be established that sufficient Government ownership and commitment exist to ensure successful implementation and sustainability.

8. Data needed to complete project planning

- Properties of recipients and scope of on-going nutritional intervention.
- Responsible parties for evaluation and follow-up to the intervention (ideally, this should be a high level Government body).
- Situation as regards public acceptance.
- Available infrastructure in terms of skilled manpower and facilities (including relevant equipment in hydrology and food laboratories, if applicable).
- Intra- and inter-country collaborative arrangements.

9. Cost-benefit picture

In order to help governments appreciate the value of the technology, the IAEA should introduce the expected benefit of isotope evaluations of nutritional evaluations into the equations used by development organisations. A simple decision tree model might be sufficient to show that such an assessment has sufficient socio-economic impact to warrant the investment, provided that the recommendations are implemented. Increased cost-sharing in this type of project by development partners, and on-going national activities, would indicate that this message is getting across.

Several approaches are currently used to estimate the costs of malnutrition to society. It is possible to define the number of preventable deaths and estimate the **lost economic productivity** based on remaining years (life expectancy), mean salary, percent unemployment, and discount rate to bring future economic benefit to present terms. Another way is to estimate the **cost of disability** as in the case of nutritional deficits that affect mental development. Iron deficiency, for instance, affects later IQ by 5-7 points even if treated, and this can be translated into economic terms in decreased educational achievement and lower productivity that in turn affects income. These cost factors are often combined. Some analyses also consider **resources wasted in education and health programmes,** as both these human capital components can be linked to nutrition during early life.

More recently, economists have been using the concept of DALY (**Disability Adjusted Life Years**) to estimate the burden of disease to society. DALY assume that the best measure of lost health and nutrition is lost time itself and not money or other arbitrary units. Thus, recent World Bank estimates show that the cost of preventing all micronutrient deficiencies is less than US $ 50 per DALY. It follows that, whereas the estimated cost of preventing micronutrient deficits is around 0.3 % of GNP, the benefits to society related to improved productivity derived from preventing disability and death is in the order of 5 % of GNP. The benefit to cost ratio of such an intervention is 17 to 1. (World Bank 1996).

10. Other TC applications within the theme of Isotope Nutrition

Other applications in the area of nutrition which might fit the Model Project criteria include:

⇒ Training of decision-makers in the value of nutritional evaluations using isotopes, and nutritional parameters as social indicators.
⇒ Nutritional parameters in the selection of new plant varieties with low antiquality and enhanced proquality components.
⇒ Studies of the effect of pollution through trace-element up-take in the population in the context of large environmental projects and environmental impact assessments.

⇒ Monitoring of some bacterial infections associated with malnutrition (helicobacter pylori)

Candidate Countries

In order to operationalise the thematic plan, the expert group arrived at the following recommendations, taking in to consideration both national capabilities and government programmes:

Latin America:

Thanks to the existence of the strong regional centre in Santiago and a strong network of institutions in Latin America, the panel strongly recommended a regional programme encompassing counterparts with strong technical and managerial skills and linkages to the interventions of Public Health Agencies. The following countries were recommended to be included in such a formulation:

Brazil
Chile
Cuba
Mexico

It was later suggested that **Argentina** may be added to this list of countries.

Asia and the Pacific:

In Latin America, there was not yet an established institutional network, capable of evaluating nutritional interventions through nuclear techniques. On the other hand, the region included several countries where very large-scale interventions were taking place. It was therefore recommended that the Agency should investigate the possibility for a similar activities in Asia and the Pacific. The following candidate countries, with established links to the Agency in nutritional research, were proposed:

China
Indonesia
Malaysia
Philippines

In addition, **Pakistan** should be considered:

Africa

The Agency had began a co-operation with the Public Works and Employment Agency (AGETIP) of the Presidency of **Senegal**. An AGETIP representative made a very useful presentation to the thematic planning Expert Group. It was proposed that Senegal be seen a model case for Africa. If the project was successfully concluded, the experience in Senegal could be copied to other countries in West Africa and throughout the African continent through the "Africatip" collaborative arrangement, and through co-operation with international organisations with mandates relating to nutritional intervention programmes.

Interregional

The Expert Group also proposed that the thematic plan would benefit from formal alliances with other international organisations, to apply isotope techniques, as appropriate to evaluate nutritional interventions, under the Agency's auspices. In this context, the Expert Group recommended that the Agency pursue interregional collaboration with organisations like the World Bank, UNICEF and WFP.

Annexes:

(1) The IAEA's Co-ordinated Research on Nutrition
(2) List of participants in expert meeting on 2-4 December 1997

NUTRITION

List of Co-ordinated Research Projects (CRPs) Expected to Be Supported During the Period 1998-2000

1. Comparative international studies of osteoporosis using isotope techniques (1994-98)
2. Development and application of isotopic techniques in studies of vitamin A nutrition (1995-1999)
3. Reference Asian Man (Extrabudgetary RCA: 1995-1999, JPN funding)
4. Isotopic evaluations of maternal and child nutrition to help prevent stunting (1996-2000)
5. Isotope-aided studies of nutrient interactions in developing country populations exposed to multiple nutritional deficiencies (1998-2001)
6. Isotopic evaluations in infant growth monitoring (Extrabudgetary RCA: 1998-2000, JPN & USA funding)
7. Isotope-aided studies of nutritional factors associated with chronic and degenerative diseases during aging (1998-2001)
8. Development and validation of isotopic and complementary tools for nutritional assessment of iron status in developing country populations (1999-2002)
9. Development and validation of isotopic and complementary tools for nutritional assessment of zinc status in developing country populations (1999-2002)
10. Health promotion for adolescent girls in transitional populations in East Asia and the Pacific (1998-2000) *
11. Development and validation of isotopic and complementary tools for nutritional assessment of - household food security in developing country populations (2000-2003)
12. The use of isotopic techniques to examine the significance of infection and other insults in early childhood to diarrhoeal morbidity, mal-assimilation and failure to thrive (1999-2002) *
13. The use of isotopic techniques to study nutrient assimilation and metabolism, and body wasting in HIV (2000 -2003)*
14. The use of isotopic and nuclear techniques to measure true body composition and its relation to simple anthropometric, DEXA and other indices of body composition in different ethnic groups (1999-2002) *
15. Nutrition and pollution interactions using isotopic and nuclear techniques (2000 - 2003) *
16. Seasonal effects on nutritional status in men and women in subsistence economies (1999 - 2002) *
17. Assessment of micronutrient requirements using immune function as an outcome indicator (1999 - 2002) *

* = high priority activities awaiting financing

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